10/564002

IAP15 Rec'd PCT/PTO 09 JAN 2006

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METHOD FOR IDENTIFYING THE TIRE TYPE MOUNTED ON A MOTOR VEHICLE

BACKGROUND OF THE INVENTION

[0001] The invention relates to a method for identifying the type of tire installed on a vehicle by determining at least one characteristic tire property, which describes the type of tire installed on a motor vehicle from a peak-frequency fp of a frequency spectrum of at least one motor vehicle tire.

[0002] For improved safety, modern motor vehicles and their passengers are equipped with an increased number of electronic auxiliary systems such as antilock braking systems (ABS) or electronic stability programs (ESP). For improving the control algorithms of these electronic auxiliary systems, a method is known from EP 0 783 983 B1, which, for example, detects based on the rotational speeds of the wheels of the vehicle, whether summer or winter tires are mounted on the vehicle. The control algorithms of the ABS-controller are thereupon adapted to the type of tires (summer or winter tires) identified. Summer and winter tires feature differences in tire properties, for example, differences in profile rigidity, which, in this case, can affect the maximum deceleration to be transmitted. Adapting the ABS-controller to the identified tires thus serves to improve active safety.

[0003] Furthermore, EP 0 578 826 B1 describes a device for measuring the state of tire pressure. The device detects a loss of tire pressure by analyzing the vibration characteristics of a motor vehicle tire using Fourier-analysis or similar method. For this purpose, the shift in a resonance frequency, also referred to as peak-frequency, is analyzed. Fig. 1 shows a typical example of a tire with a distinct peak-frequency fp of approximately 40 Hz for a

given tire pressure. A shift in this peak-frequency to higher or lower frequencies is interpreted by the device of the prior art as a loss of tire pressure.

SUMMARY OF THE INVENTION

[0004] The object of the invention is to provide another method for identifying the tire type installed on the motor vehicle, wherein the tire type installed on the motor vehicle is identified on the basis of its vibration properties.

[0005] This object of the invention can be achieved by a method of determining at least one characteristic tire property, which describes the type of tire installed on a motor vehicle from a peak-frequency fp of a frequency spectrum of at least one motor vehicle tire.

[0006] In the scope of this invention, the term "characteristic tire property" should be understood as a parameter such as, for example, the pressure sensitivity of the rolling circumference of the tire, pressure sensitivity of peak-frequency fp, etc.

[0007] The term "peak-frequency" should hereinafter generally be understood as a parameter for characteristic natural vibrations of the tire, wherein in addition to the actual natural frequency, dampening is also meant, which in Figure 1 appears as an area of breadth or rather in the form of a rise in the frequency spectrum around 40 Hz.

[0008] The term "target pressure of the motor vehicle tire" should be understood as a set tire pressure such as, for example, a target pressure prescribed by a tire manufacturer for a given load.

This target pressure depends on the type of vehicle, vehicle load and the tire dimensions used, among other factors.

[0009] The inventive method should preferably be implemented only if the present tire pressure equals the target pressure of the vehicle tire.

[0010] It is advantageous if the driver adjusts or checks the target pressure of the vehicle tires using a tire inflator or a tire pressure gauge.

[0011] After having adjusted and/or checked the target pressure of the vehicle tires, the driver preferably activates an actuating mechanism, in particular a reset button, which initiates the inventive method.

[0012] It is advantageous if the characteristic tire properties at a prescribed target pressure of the motor vehicle are stored in a characteristic map in the form of a mathematic function or in a similar way. For example, the peak-frequency of a specific type of tire with a specific tire size at a specific tire pressure can be calculated from such a characteristic map. The characteristic map can also contain information on the tire or rather air pressure or correction values for eliminating temperature influences. This characteristic map can be presented, for example, as a table or diagram, wherein the various types of tires are plotted according to function f(fp, v) against tire speed v and peak-frequency fp. From this characteristic map the peak-frequency fp at a specific speed v can be read or rather derived, while a peak frequency fp at a specific tire speed can be determined from the function f(f0, v),

e.g. by interpolation or examination of the slope. The course of peak-frequency fp against the tire speed v yields direct information on the type of tire present. Such a characteristic map must be vehicle-specific.

[0013] At least one characteristic tire property is preferably made available to other motor vehicle systems such as an antilock braking system (ABS), an electronic stability program (ESP), a deflation detection system (DDS) or other systems of the prior art.

[0014] This method for identifying tire type is also very well suited for characterization of tires for a tire-pressure-monitoring-systems operating on the basis of the pressure-induced change in tire rolling circumference U or on the basis of pressure-dependent peak-frequency fp. For this tire-pressure-monitoring-system there is the problem that the pressure sensitivity of the tire rolling circumference dU/dp or rather the pressure sensitivity of the peak-frequency dfp/dp greatly depends on the tires. It is to be noted that the peak-frequency fp characterizing the tires is a function of speed. It should also be ensured that the determination of the peak-frequency fp occurs at the same speed or within the same speed range. The peak-frequency is also a function of wheel moment. Therefore, when determining peak-frequency, only a limited wheel moment range is allowed for the particular tire speed or peak-frequency is determined only by taking into consideration wheel moment. Because it is possible for any motor vehicle to have all of its wheels outfitted with nonidentical tires, various peak-frequencies can be present.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Additional preferred embodiments can be found in the following description of several embodiments with reference made to the attached figures.

[0016] Fig. 1 a known frequency spectrum of a tire,

[0017] Fig. 2 various tire types/dimensions with different peak frequencies at a particular speed, and

[0018] Fig. 3 the relation between pressure sensitivity and peak-frequency at a particular speed.

DETAILED DESCRIPTION OF THE DRAWINGS

[0019] Fig. 1 illustrates a typical frequency spectrum of a tire. Frequency is given in Hertz on the X-axis, while amplitude is given in a discretionary unit on the Y-axis. In the example shown, a distinct peak-frequency fp is found at approximately 40 Hz. The frequency spectrum illustrated in Fig. 1 is determined in a manner familiar to one knowledgeable in the art from the signal of a sensor, e.g. an ABS-sensor present on the motor vehicle, which ascertains the rotational property (e.g. rotational speed) of the motor vehicle, by means of a Fourier-analysis. A distinct peak-frequency fp of approximately 40 Hz is thereby yielded. The location of the peak-frequency fp depends on the tire properties, such as tire pressure, and the speed of the motor vehicle.

[0020] The diagram in Fig. 2 illustrates peak-frequencies for various tire types/dimensions A, B, C, wherein these each feature different peak-frequencies fA, fB, fC. The illustrated interdependence between tire type and peak-frequency is a function of speed

among other factors. The diagram therefore applies only to an observed speed of a particular motor vehicle. At other speeds or with other motor vehicles, this relation can exhibit a different appearance. It has been shown that the location of the peak-frequency fp is suited for determining the type of tire present. Peak frequencies can hereby be defined as fixed values (e.g. 40 Hz) or a range of values (e.g. 38 Hz - 42 Hz) to factor in, for example, the existing fabrication tolerances of the tire. The identified tire type can be fed to other motor vehicle systems such as ABS, ESP, where it can be used for adapting control algorithms.

[0021] Fig. 3 illustrates the interdependence or rather correlation between the location of peak-frequency fp and the pressure sensitivity of the tire rolling circumference dU/dp at a particular speed for a particular motor vehicle. Peak-frequencies with a higher frequency also exhibit a higher pressure sensitivity of the tire rolling circumference dU/dp. This realization is incorporated into the inventive method to establish the detection thresholds for a loss of tire pressure. In tire-pressure-monitoring-systems of the prior art the detection thresholds were established independently of the tire characteristics, which in many systems led to false or absent warnings according to design. The factoring in of tire characteristics in a tire-pressure-monitoring-system facilitates improved detection of a loss of tire pressure even when pressure thresholds are nearly equal in all tires. For this purpose, the interdependence between peak-frequency fp and the pressure sensitivity of the rolling circumference dU/dp is stored for example in a characteristic map or in the form of a mathematic function.

[0022] The individual steps of the inventive process are illustrated below.

[0023] Step 1: Adjustment of target pressure (recommended tire pressure) of the motor vehicle tires and actuation of a reset button to initiate the inventive method.

[0024] Step 2: Determination of peak-frequency fp at target pressure of individual tires factoring in the tire speed and wheel moment from the frequency spectrum of the Fourier-analysis in a way familiar to one knowledgeable in the art.

[0025] Step 3: Determination of the characteristic tire properties such as pressure sensitivity of the tire rolling circumference or pressure sensitivity of the peak-frequency fp from a stored characteristic map (see Fig. 3).

[0026] If the inventive method is used in other motor vehicle systems (e.g. ABS, ESP, DDS), the following steps may also be necessary.

[0027] Step 4: Selection of the applied detection thresholds / warning thresholds as a function of e.g. pressure sensitivity of the tire rolling circumference or the pressure sensitivity of peak-frequency fp.

[0028] Step 5: Transmission of the speed-dependent peak-frequency fp at target pressure and the detection / warning thresholds to a downstream system e.g tire-pressure-monitoring-system (DDS), ABS, ESP, etc.

[0029] In principle, the pressure sensitivity of the rolling circumference or the pressure sensitivity of the peak-frequency can be ascertained via correlating vibration properties of the tires, which can be analyzed in other ways, e.g. through the analysis of characteristic tire acceleration.